

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

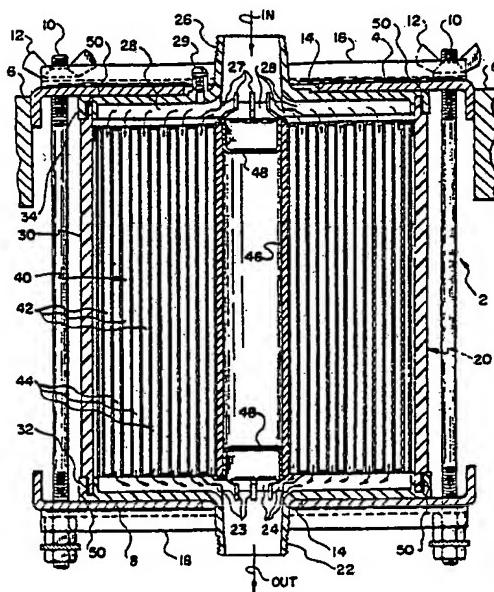
**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**

*THIS PAGE BLANK (USPTO)*



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>4</sup> :  B01D 25/24, 35/30, 27/08		A1	(11) International Publication Number: WO 88/ 03431  (43) International Publication Date: 19 May 1988 (19.05.88)
<p>(21) International Application Number: PCT/US87/02842            (22) International Filing Date: 29 October 1987 (29.10.87)</p> <p>(31) Priority Application Number: 926,615            (32) Priority Date: 4 November 1986 (04.11.86)            (33) Priority Country: US</p> <p>(71) Applicant: EASTMAN KODAK COMPANY [US/US];            343 State Street, Rochester, NY 14650 (US).</p> <p>(72) Inventors: EDWARDS, Evan, A. ; 2 Prospect Road,            Pittsford, NY 14534 (US). MAYO, Richard ; 8842            Wandering Way, Baldwinsville, NY 13027 (US).</p> <p>(74) Agent: STRNISHA, Herman, J.; 343 State Street, Ro-            chester, NY 14650 (US).</p>		<p>(81) Designated States: AU, BE (European patent), CH (Eu-            ropean patent), DE (European patent), FR (Euro-            pean patent), GB (European patent), IT (European            patent), JP (Utility model), NL (European patent).</p> <p><b>Published</b>  <i>With international search report.            Before the expiration of the time limit for amending the            claims and to be republished in the event of the receipt            of amendments.</i></p>	
<p><b>(54) Title:</b> LIQUID FILTER APPARATUS</p> <p><b>(57) Abstract</b></p> <p>A liquid filter apparatus, for connection to inlet and outlet liquid lines, including a mounting holder (2) and a removable filter within the holder. The filter unit (20) includes bottom and top end caps (22, 26) with a core tube (46) and a concentric outer tube (30) extending between the end caps (22, 26). A filter element (40) between the core tube (46) and the outer tube stands on radial ribs (23) extending upward from the bottom end cap (22) and is spaced from the top end cap by similar radial ribs (23) extending downward from the top end cap (26), these ribs creating radial flow channels above and below the filter element (40). The filter element (40) is a wound spiral of filter material (43) and separator (41) forming a plurality of axial flow channels (42, 44). Some of these axial flow channels (42, 44) are open at the top to receive liquid from the top radial flow channel and closed at the bottom, and some of the axial flow channels (42, 44) are closed at the top and open at the bottom to discharge liquid into the bottom radial flow channel. Filter action is by radial flow, through the filter material (43) from the open-top channels (42) to the open-bottom channels (44). The holder (2) includes upper and lower mounting plates (4, 8) and tie rods (10) between them to releasably hold the unit together and to permit removal and replacement of the filter. Means (29) are provided to vent air from the system.</p> 			

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT Austria	FR France	ML Mali
AU Australia	GA Gabon	MR Mauritania
BB Barbados	GB United Kingdom	MW Malawi
BE Belgium	HU Hungary	NL Netherlands
BG Bulgaria	IT Italy	NO Norway
BJ Benin	JP Japan	RO Romania
BR Brazil	KP Democratic People's Republic of Korea	SD Sudan
CF Central African Republic	KR Republic of Korea	SE Sweden
CG Congo	LI Liechtenstein	SN Senegal
CH Switzerland	LK Sri Lanka	SU Soviet Union
CM Cameroon	LU Luxembourg	TD Chad
DE Germany, Federal Republic of	MC Monaco	TG Togo
DK Denmark	MG Madagascar	US United States of America
FI Finland		

- 1 -

LIQUID FILTER APPARATUS  
BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a disposable liquid  
5 filter supported by an open mounting holder allowing simple  
replacement of the filter.

Description of the Prior Art

Most liquid filters are installed by the user in  
a steel housing which is a part of the filter and of the  
10 liquid path through it. Such a prior art housing typically  
has inlet and outlet pipe connections and is itself a pres-  
sure vessel with a heavy cover clamped in place to make the  
unit leak proof and to safely contain the liquid pressure.  
For some applications, for example, where the liquid pres-  
15 sure does not exceed 75 psi, it may be more convenient and  
less expensive to have a disposable filter unit in its own  
plastic housing adapted for direct hose connections at  
inlet and outlet.

The prior art includes U.S. Patents 3,529,726 to  
20 Keenan; 3,820,661 to Pages; and 4,505,816 to Wozniak et  
al. Keenan discloses a filter assembly including a tie rod  
mounting holder and filter unit, the filter unit being  
removable from the holder by loosening the tie rods. Pages  
discloses a filter assembly, also held together by tie  
25 rods, and including a filter element having a plurality of  
axial fluid channels. These channels in Pages are open at  
both ends for a continuous fluid flow in series from one to  
another. Wozniak et al. discloses a filter assembly having  
radial flow channels in one of its end caps. While these  
30 items of prior art variously relate to some of the elements  
of this invention, i.e., tie rods, removable and replace-  
able filter unit, and radial flow end caps, they do not  
relate to the combination or the principle of operation of  
this invention.

35 SUMMARY OF THE INVENTION

The present invention may be summarized as a  
liquid filter apparatus, for connection to inlet and outlet  
liquid lines, and including a mounting holder and a

- 2 -

removable disposable filter unit mounted in the holder. The disposable filter unit includes bottom and top end caps, with a core tube plugged at both ends and a concentric outer tube sealed to and extending between the end caps. The top and bottom end caps and the outer tube are made of a plastic material for economy and disposability. A filter element between the core tube and the outer tube stands on radial ribs extending upward from the bottom end cap and is spaced from the top end cap by similar radial ribs extending downward from the top end cap, these ribs creating radial flow channels above and below the filter element. The filter element is a wound spiral of a sandwich including a flat filter sheet material and a corrugated impermeable polymeric separator sheet, forming a plurality of axial flow channels. Some of these axial flow channels are open at the top to receive liquid from the top radial flow channel and closed at the bottom, and some of the axial flow channels are closed at the top and open at the bottom to discharge liquid into the bottom radial flow channel. Filter action is by radial flow, through the filter material, from the open-top channels to the open-bottom channels. The mounting holder includes upper and lower mounting plates and tie rods between them to releasably hold the filter unit together and to permit easy removal and replacement of the filter unit. The mounting plates and tie rods give strength to the filter unit, preventing liquid pressure from blowing off the end caps. Means are provided to vent air from the filter unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional elevation view of the filter and mounting holder of this invention.

Figure 2 is a top view of the upper mounting holder of FIG. 1.

Figure 3 is a partial front view of the mounting holder of FIG. 2.

Figure 4 is a schematic top view, somewhat enlarged, of a filter element according to this invention.

- 3 -

Figure 5 is a still further enlarged schematic detail of FIG. 4.

Figure 6 is a bottom view of the top end cap.

Figure 7 is a top view of the bottom end cap.

5

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, the mounting holder and filter of this invention are shown in combination, the mounting holder being generally indicated at 2 and the filter unit at 20. Mounting holder 2 includes an upper 10 mounting plate 4 fastened to a stationary support means such as flanged brackets exemplified at 6, and a similar lower mounting plate 8 which hangs from upper plate 4 on four tie rods 10. Tie rods 10 include wing nuts 12 at their tops by which the assembly is tightened for normal 15 operation and loosened for removal and replacement of the filter 20. Each of the mounting plates is somewhat "C" shaped, having an open aperture 14 facing forward of the apparatus (see also FIG. 2). A pair of upper channel beams or cross bars 16 extend across the top of upper plate 4, 20 one extending between the two tie rods 10 at the rear and one extending between the two tie rods 10 at the front. Similarly, a pair of lower channel beams or cross bars 18 extend across the bottom of lower plate 8, one extending between the two tie rods 10 at the rear and one extending 25 between the two tie rods 10 at the front. Cross bars 16 and 18 bear on their respective upper and lower mounting plates by means of the tie rods 10 and wing nuts 12 providing longitudinal strength to the mounting plates. Cross bars 16 and 18 in the front of the unit are mounted for 30 rotation on one of the front tie rods so they can be swung open when the wing nuts are loosened to permit placement and removal of the filter 20. The upper front cross bar 16 includes depending heel piece 17 to fill the space of the open aperture 14 when the mounting holder is closed. A 35 similar heel piece, not shown, is mounted atop the lower front cross bar 18 for the same purpose. This makes the mounting plate-heel combination flush at top and bottom. Thus, when the filter is in place and the mounting holder

- 4 -

is clamped over it, the end surfaces of the top and bottom end caps are substantially in total contact with the flush mounting plate-heel combination at top and bottom. This prevents distortion of the filter and the consequent breaking of seals when hydraulic pressure is applied.

The filter 20 is an integral unit which fits into the mounting holder 2 and is laterally removable from it.

Filter 20 includes a bottom end cap 22 (see also FIG. 7) having a central outlet port "OUT" which is adapted, as for example by pipe threads, for connection to an outlet liquid line. A similar top end cap 26 (see also FIG. 6) includes a central inlet port "IN" which is also adapted, as for example by pipe threads, for connection to an inlet liquid line.

Bottom end cap 22 includes a plurality of upstanding radial ribs 23 creating a plurality of radial outlet flow channels 24 and supporting the filter element 40. Top end cap 26 includes a plurality of depending radial ribs 27 creating a plurality of radial inlet flow channels 28 over the filter element 40. An outer cylindrical tube 30 fits within peripheral flange 32 in the bottom end cap 22 and peripheral flange 34 in the top end cap 26. These

connections between outer tube 30 and the bottom and top end caps 22 and 26 are sealed with a sealant such as an electro-magnetically actuated polypropylene adhesive sealer or similar suitable sealing composition so that the filter unit is liquid-tight. The end caps and the outer tube are all of a plastic material such as polypropylene for economy and disposability.

A normally closed vent passage 29 is provided in the top end cap 26 to remove air or gases from the system as necessary. The sealing engagement of the bottom end cap 22 with the outer tube 30, and the sealing engagement of the top end cap 26 with the outer tube 30, are all represented by deposits 50 of sealant at the respective locations of connection.

A filter element 40 (see also FIG. 4) is a spiral wound roll of a sandwich including a flat filter sheet material 43, interleaved with a corrugated polymeric separator sheet 41 resting on the tops of upstanding ribs

- 5 -

23 of the bottom end cap. The corrugations of the filter element provide spacing between successive layers of the wound roll, which spaces are axial flow channels for the liquid passing through the filter. Alternate axial flow  
5 channels 42 are blanked off at the bottom, while successive alternate axial flow channels 44 are blanked off at the top so that fluid enters at the top of the open-top channels 42 and leaves at the bottom of the open-bottom channels 44. Filter action is by way of radial flow, through the filter  
10 material 43, from the open-top channels 42 to the open-bottom channels 44 as indicated in FIG. 5. The filter element 40 is formed around a core tube 46 which is sealed at its ends by plugs 48. This gives structural support to the filter element and prevents straight axial flow through  
15 its center from inlet to outlet. The blanking of the ends of the flow channels is formed by a hot melt plastic.

When a filter unit is to be changed, the fluid system is shut down and disconnected at the inlet and outlet connections. Then the mounting holder 2 is opened  
20 by loosening the wing nuts and tie rods and the front cross bars are swung out of the way. The filter unit 20 is then simply pulled forward out of the holder. A replacement filter unit 20 is then inserted, clamped in place, and connected to the liquid inlet and outlet lines.

25

30

35

- 6 -

We claim:

1. A liquid filter apparatus for connection to inlet and outlet liquid lines and including a mounting holder and an integral filter unit removably mounted in  
5 said holder:  
said filter unit including:
  - a. a bottom end cap having a central outlet port adapted for connection to an outlet liquid line and including a plurality of upstanding radial ribs forming radial outlet flow channels;
  - b. a cylindrical outer tube in sealing engagement with said bottom end cap and extending upwardly therefrom;
  - c. a top end cap mounted atop said outer tube and in sealing engagement therewith, said top end cap having a central inlet port adapted for connection to an inlet liquid line and including a plurality of depending radial ribs forming radial inlet flow channels;
  - d. a cylindrical filter element disposed within said outer tube between said end caps and spaced from said end caps by said radial ribs;
- said mounting holder including:
  - e. a lower mounting plate adapted to support said bottom end cap and an upper mounting plate adapted to bear on said upper end cap, at least one of said mounting plates having an opening in one side thereof to permit the lateral insertion of said filter therein, one of said mounting plates being fixed to a stationary support means; and
  - f. tie rods extending between said upper and lower mounting plates adapted for releasable clamping engagement to firmly hold said

- 7 -

filter in place and to provide longitudinal strength to said filter apparatus.

2. A liquid filter apparatus as defined in Claim 1, further including means to vent air from said 5 filter.

3. A liquid filter apparatus as defined in Claim 1, further including a central core tube around which said filter element is disposed, said core tube being capped at its ends to prevent straight axial liquid flow therethrough.  
10

4. A liquid filter apparatus as defined in Claim 1, said mounting plates each having an opening in one side thereof to permit lateral insertion of said filter therein.  
15

5. A liquid filter apparatus as defined in Claim 1 including means to effect a coplanar contact interface between said end caps and said mounting holder.  
20

6. A liquid filter apparatus as defined in Claim 1 including means on said mounting holder to provide a surface flush with said mounting plates for supporting contact with said end caps.  
25

7. A liquid filter apparatus as defined in Claim 1 in which there are four of said tie rods, and further including upper cross bars extending between pairs 25 of said tie rods and lower cross bars extending between pairs of said tie rods, at least one of said cross bars including a heel for insertion into said opening of said mounting plate forming a flush surface therewith for contact with the contiguous one of said end caps.  
30

8. A liquid filter apparatus as defined in Claim 1 in which said filter element includes a porous filter material defining a plurality of axial flow channels, some of said axial flow channels being open at their tops to receive liquid from said radial inlet flow channels and closed at their bottoms, and some of said axial flow channels being closed at their tops and open at their bottoms to discharge liquid into said radial outlet flow channels.  
35

- 8 -

9. A liquid filter apparatus for connection to inlet and outlet liquid lines and including a mounting holder and a filter unit removably mounted in said holder:

said mounting holder including upper and lower 5 apertured mounting plates and a plurality of tie rods to releasably clamp said filter unit between said upper and lower plates;

said filter unit including:

- a. top and bottom end caps each having a central port for connection to one of said liquid lines and each including a plurality of inwardly facing radial ribs forming radial flow channels;
- b. a cylindrical outer tube between said end caps and sealed therewith forming a liquid-tight filter housing; and
- c. a cylindrical filter element disposed within said housing and spaced from said end caps by said radial ribs, said filter element including a porous filter material defining a plurality of axial flow channels, a number of said axial flow channels being open at their tops to receive liquid from the radial flow channels communicating therewith and closed at their bottoms, others of said axial flow channels being closed at their tops and open at their bottoms to discharge liquid into the radial flow channels communicating therewith, whereby filter action is by way of radial flow through said filter material from those axial flow channels with open tops to those axial flow channels with open bottoms.

10. A liquid filter apparatus as defined in 35 Claim 9, further including means to vent air from said filter.

11. A liquid filter apparatus as defined in Claim 9, further including a central core tube around which

- 9 -

said filter element is disposed, said core tube being capped at its ends to prevent straight axial liquid flow therethrough.

12. A liquid filter apparatus as defined in  
5 Claim 9, said mounting plates each having an opening in one side thereof to permit lateral insertion of said filter therein.

13. A liquid filter apparatus as defined in  
Claim 9 including means to effect a coplanar contact  
10 interface between said end caps and said mounting holder.

14. A liquid filter apparatus as defined in  
Claim 9 including means on said mounting holder to provide a surface flush with said mounting plates for supporting contact with said end caps.

15. An integral liquid filter unit for removable insertion into a mounting holder, said filter unit including:

- a. top and bottom end caps each having a central port for connection to one of said liquid lines and each including a plurality of inwardly facing radial ribs forming radial flow channels;
- b. a cylindrical outer tube between said end caps and sealed therewith forming a liquid-tight filter housing; and
- c. a cylindrical filter element disposed within said housing and spaced from said end caps by said radial ribs, said filter element including a porous filter material defining a plurality of axial flow channels, a number of said axial flow channels being open at their tops to receive liquid from the radial flow channels communicating therewith and closed at their bottoms, others of said axial flow channels being closed at their tops and open at their bottoms to discharge liquid into the radial flow channels communicating therewith, whereby filter action

- 10 -

is by way of radial flow through said filter material from those axial flow channels with open tops to those axial flow channels with open bottoms.

5

10

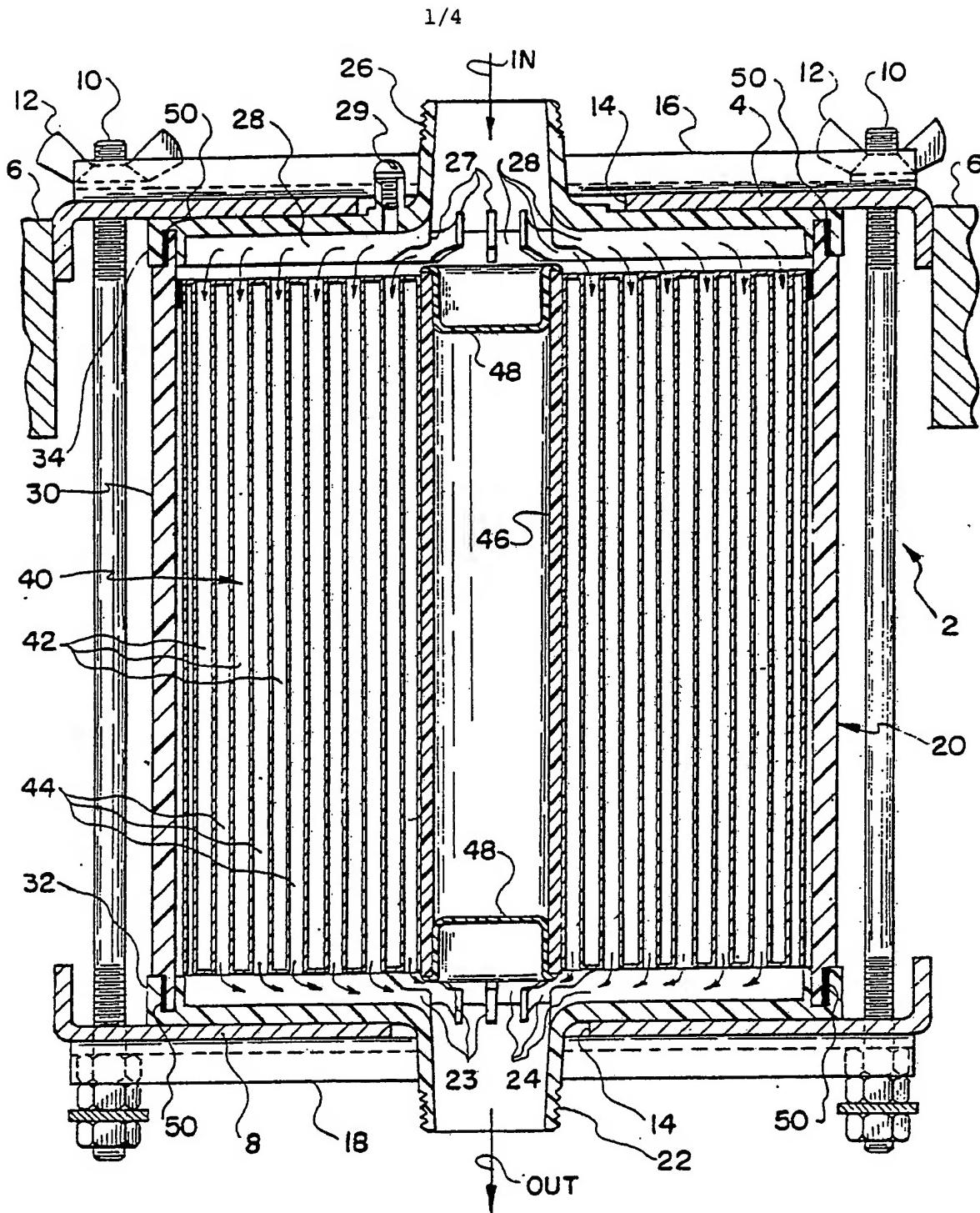
15

20

25

30

35



**FIG. I**

2/4

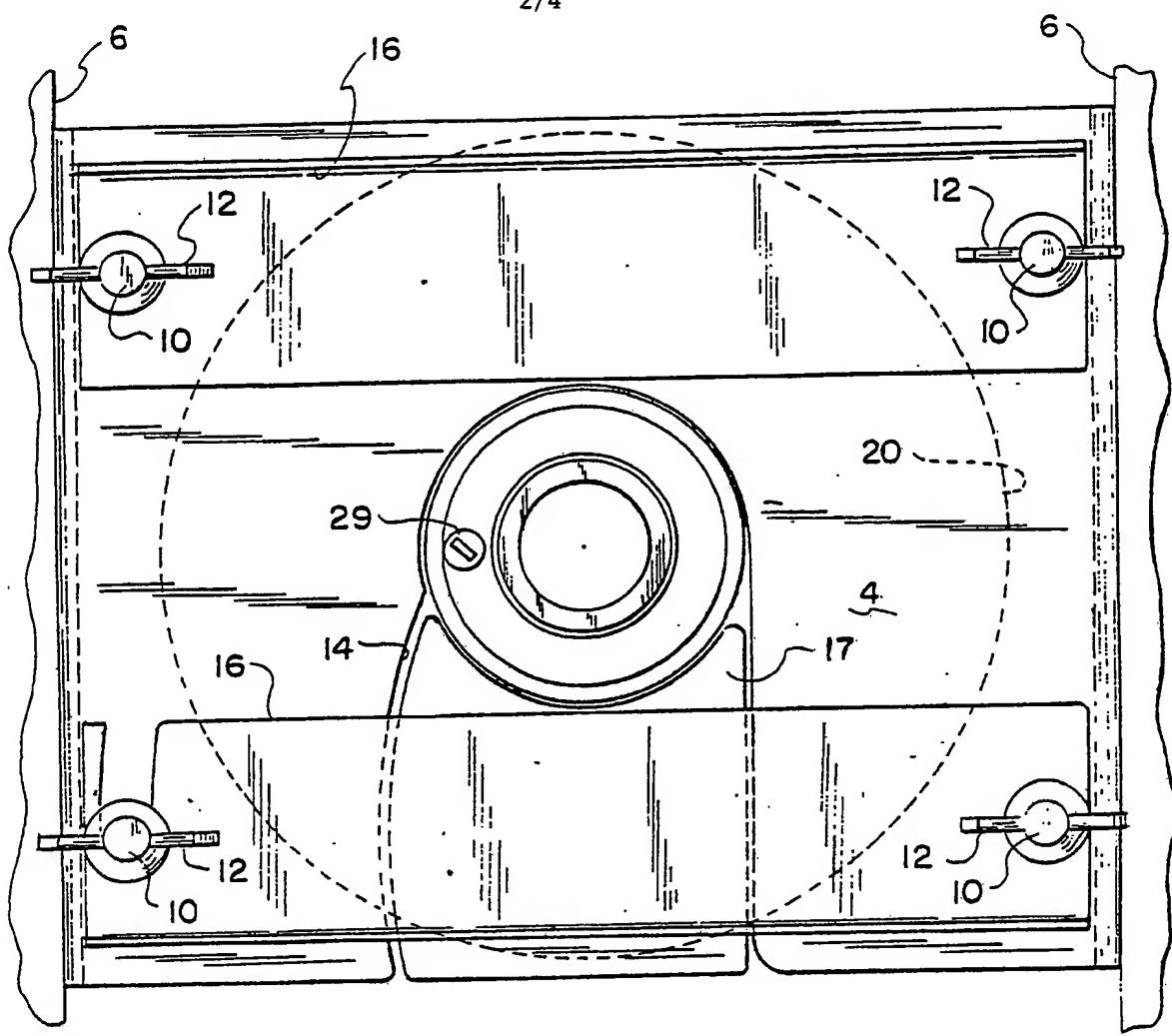


FIG. 2

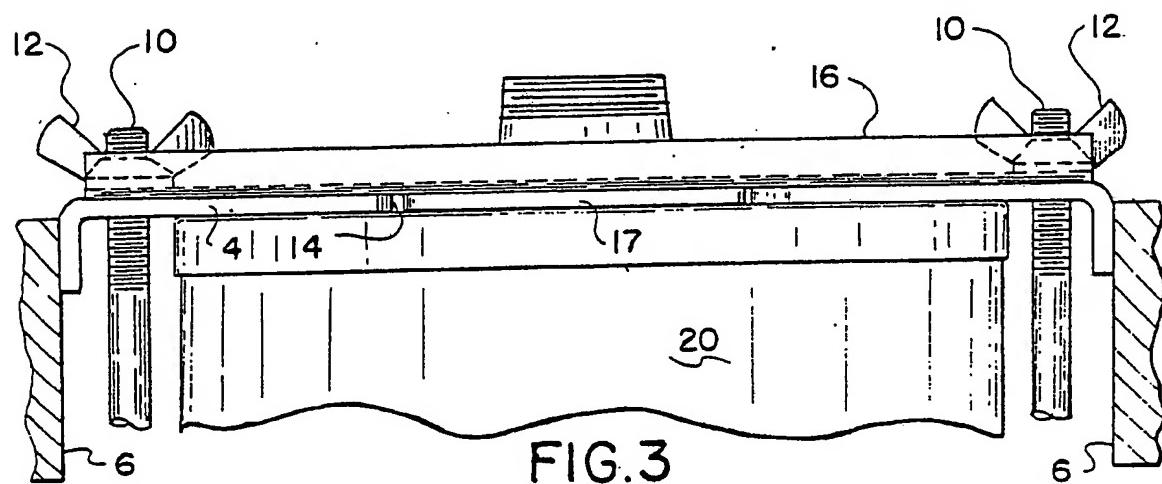


FIG. 3

3/4

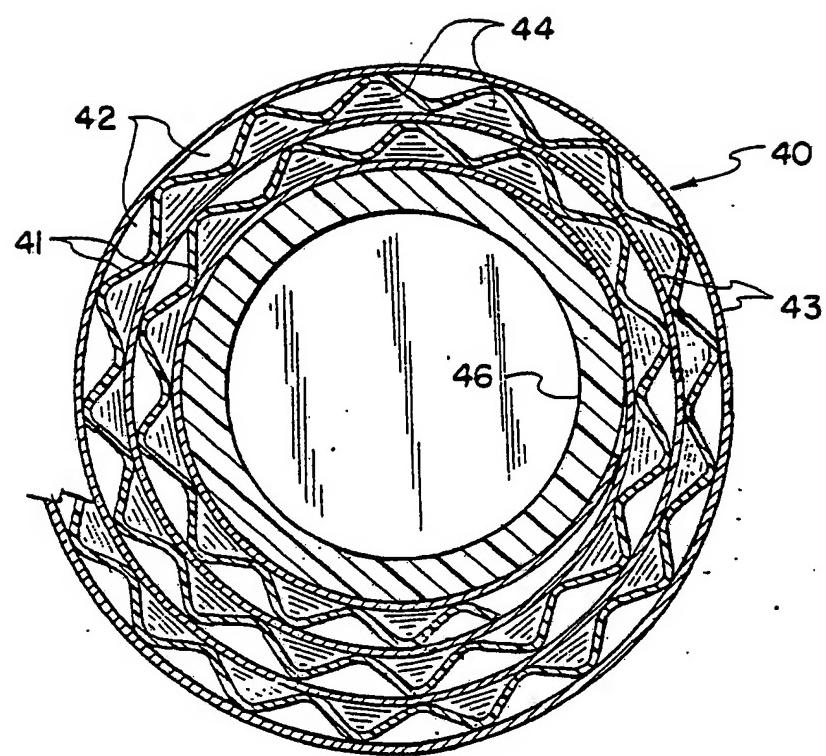


FIG. 4

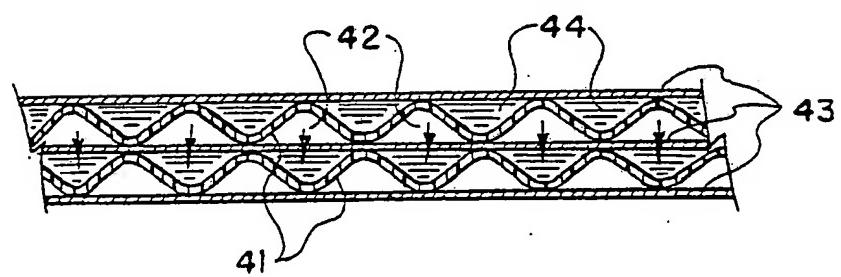
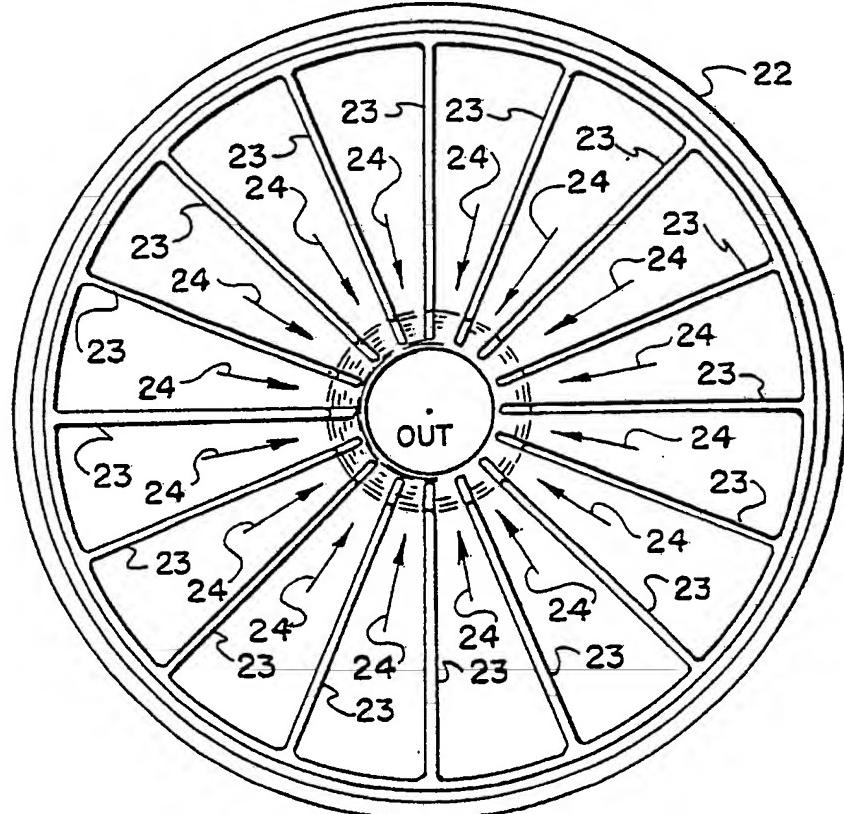
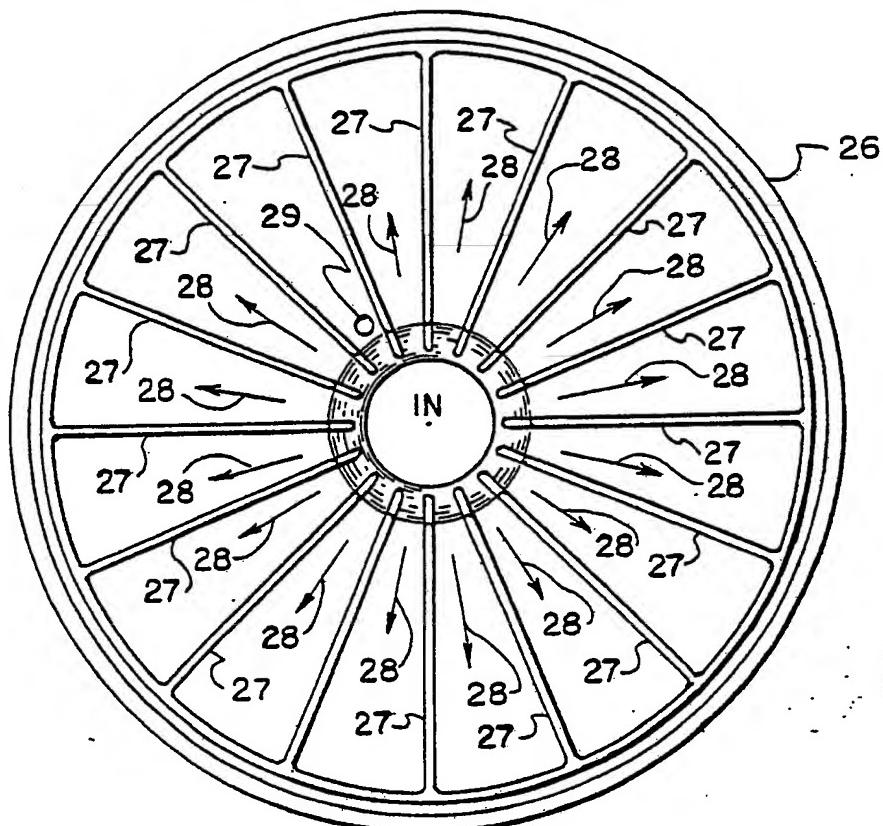


FIG. 5

4/4



# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 87/02842

## I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) <sup>4</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC<sup>4</sup>: B 01 D 25/24; B 01 D 35/30; B 01 D 27/08

## II. FIELDS SEARCHED

Minimum Documentation Searched <sup>7</sup>

Classification System	Classification Symbols
IPC <sup>4</sup>	B 01 D

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	GB, A, 919898 (PARMATIC INC.) 25 July 1960, see the whole document	15
A	--	1,3,4,8,9, 11
Y	FR, A, 2148726 (HERFIL CO.) 23 March 1973, see figures 2-4; page 4, lines 1-5	15
A	--	1,9
A	FR, A, 1050918 (R. BOSCH GmbH) 12 January 1954	1,8,9,15,11, 13
A	--	1,9
A	US, A, 3529726 (KEENAN) 22 September 1970, see figures 1-3 cited in the application	1,4,7,9,12, 15
A	--	1,9,15
A	US, A, 4310419 (NARA et al.) 12 January 1982	1,9,15
A	--	1,9,15
A	WO, A, 83/01582 (DONALDSON CO. INC.) 11 May 1983, see figures 1,2,4,6	1,9,15
	-----	

- \* Special categories of cited documents: <sup>10</sup>
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

8th February 1988

Date of Mailing of this International Search Report

18 MAR 1988

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. US 8702842  
SA 19612

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 03/03/88. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A- 919898		None		
FR-A- 2148726	23-03-73	None		
FR-A- 1050918		CH-A-	300583	
US-A- 3529726	22-09-70	None		
US-A- 4310419	12-01-82	JP-A-	56133005	17-10-81
WO-A- 8301582	11-05-83	FR-A-	2515526	06-05-83
		AU-A-	1014283	18-05-83
		US-A-	4410427	18-10-83
		GB-A, B	2119672	23-11-83
		DE-A-	3249151	12-01-84
		CA-A-	1169362	19-06-84
		AU-B-	548875	02-01-86
		US-A-	4589983	20-05-86